

## **P-9.4 Explain how the rate of flow of a fluid is affected by the size of the pipe, friction, and the viscosity of the fluid**

### **Revised Taxonomy Levels 2.7 B Explain conceptual knowledge**

In physical science, students were introduced to viscosity as a physical property of a fluid and they studied friction as an opposing force for moving objects.

#### **It is essential for students to**

- ❖ Understand that the flow rate can be measured several ways
  - Volumetric flow rate ( $\text{ft}^3/\text{sec}$ ), ( $\text{gal}/\text{min}$ ), ( $\text{l}/\text{sec}$ ), ( $\text{m}^3/\text{sec}$ )
    - ◆ The volume of fluid flowing past a given point in a fluid flow system per unit of time
  - Mass flow rate, ( $\text{lb}/\text{sec}$ ) or ( $\text{kg}/\text{sec}$ )
    - ◆ The amount of fluid mass flowing past a given point in a fluid flow system per unit of time
- ❖ Understand that the flow rate is directly proportional to the square of the diameter of the pipe.
- ❖ Understand that friction has a negative affect on the flow rate of a fluid system in two ways
  - Because of the friction of a fluid in contact with a pipe, the flow rate of the fluid is slower near the walls of the pipe than at the center.
  - The smoother, cleaner, and larger a pipe is, the less effect pipe friction has on the overall flow rate
  - Compare laminar and turbulent flow
  - Explain why a freely falling object has terminal speed
- ❖ Understand that the viscosity of a flowing fluid is a direct indication of the work which must be done to maintain that fluid in steady flow, so the higher the viscosity of the liquid, the lower the flow rate.
  - Identify the normal laboratory method of measuring viscosity

### **Assessment**

The verb, explain means that the major focus of assessment should be for students to “construct a cause and effect model”. In this case, assessments will ensure that students can model how pipe diameter, friction, and viscosity of the liquid affect its flow rate. Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students can construct a cause and effect statement relating each of these factors affect the flow rate in a given fluid system.